REMARKS

Claims 1-4, 8-24, 26-31, 40-59, 63-83, 92-113, 115-135 and 144-152 currently stand rejected under 35 U.S.C. § 103(a). Claims 1, 3, 8, 19, 22, 29-31, 49-50, 52, 57, 66, 77-78, 81-83, 101, 106, 109, 111, 120, 131 and 133-135 have been amended. Claims 153-155 have been added. No new matter has been added.

Based on the manifest differences between the cited references and the claimed invention, the Applicant believes that the following remarks will convince the Examiner that the rejections in the February 23, 2007 Office Action should be reconsidered and withdrawn.

A. Claim Rejections Under 35 U.S.C. § 112, Paragraph 2

The Examiner rejected claims 8, 66 and 120 under 35 U.S.C. § 112, Paragraph 2, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. According to the Examiner, the phrase "concentric configuration" in claims 8, 66 and 120 "is vague and indefinite because it fails to indicate what the part is concentric with respect to or relative to." (Office Action of February 23, 2007, page 2). Claim 8, which is indicative of claims 66 and 120, has been amended, and now recites "two or more of said evaporator, said hollow transport tube and said reservoir cylinder are machined from a single piece of refractory material in essentially a concentric configuration with respect to each other." In light of these amendments, Applicant respectfully requests the Examiner's withdrawal of the § 112 rejection of claims 8, 66 and 120.

B. Claim Rejections Under 35 U.S.C. § 103(a)

Claims 5-7, 25, 32-39, 60-62, 84-91, 114 and 136-143 have been withdrawn from consideration. The Examiner rejected claims 1-3, 8-20, 29-31, 40-53, 55, 66-82, 92-107, 109, 115-116, 118-135 and 144-152, under 35 U.S.C. § 103(a) as being unpatentable over Sarraf U.S. Patent No. 5,558,720 ("Sarraf"), taken in view of Zega U.S. Patent No. 4,112,137 ("Zega"), De Lange U.S. Patent No. 2,508,500 ("De Lange"), Dale U.S. Patent No. 3,634,647 ("Dale"), Bennett U.S. Patent No. 2,568,578 ("Bennett") and Mercer U.S. Patent No. 5,407,000 ("Mercer"). Applicant respectfully disagrees and requests reconsideration of the Examiner's § 103(a) rejection in light of the following comments.

The Applicant respectfully draws the Examiner's attention to recent case law, which states:

> "[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. Although common sense directs one to look with care at a patent application that claims as innovation the combination of two known devices according to their established functions, it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (U.S. 2007).

However,

> "To draw on hindsight knowledge of the patented invention, when the prior art does not contain or suggest that knowledge, is to use the invention as a template

for its own reconstruction -- an illogical and inappropriate process by which to determine patentability. The invention must be viewed not after the blueprint has been drawn by the inventor, but as it would have been perceived in the state of the art that existed at the time the invention was made." (Citations omitted). *Sesonics v. Aerosonic Corp.*, 38 U.S.P.Q. 2d. 1551, 1554 (1996).

In light of *KSR*, one must look at the combination of all six of the prior art references cited by the Examiner in order to determine if the claimed invention is taught, suggested or rendered obvious. When Sarraf, Zega, De Lange, Dale, Bennett and Mercer are combined, it results in an MBE liquid evaporation source with a heated supply tank and capillary tube feed for filling the evaporator; an evaporator continuously supplied with liquid metal from the supply tank; a separate heater on the feed pipe; a piston in the supply tank pushing the liquid metal into the feed tube; a supply pipe with a heater and thermocouple based heater control means; and a level sensor for sensing the level in an evaporator and controlling the movement of a piston feeder. However, the combination of the cited references, in particular, the use of a piston and a capillary feeding tube, would make the system inoperable.

More specifically, Sarraf uses capillary action to transport the metal to the evaporation surface via a capillary wick formed in the capillary tube. This capillary tube is coated with sintered tungsten powder. Such use of a small diameter capillary tube actually "wets" or chemically attracts the liquid metal in order to draw the metal up from the reservoir, through the capillary tube and into the evaporator. This is problematic in the Sarraf patent if the capillaries become contaminated (for instance with metal oxides) which would obstruct metal flow. The capillary wick can clog and become non-

functional if metal oxides or other foreign matter from the reservoir are introduced into the wick.

Additionally, the use of the sintered tungsten in Sarraf prevents calibrating the evaporator prior to use. The evaporation rate of the liquid metal is proportional to the open porosity of the tungsten, and is affected by the exposed surface area of the liquid metal wetting the tungsten. The surface area of the tungsten, and by extension, the surface area of the liquid metal, will vary based on the manufacturing method used to produce the tungsten, as well as the method used to apply the tungsten to the evaporator surfaces. Therefore, under Sarraf, the metal evaporation rate at a given evaporator temperature cannot be accurately predicted, and can vary even in similar evaporator geometries.

In contrast, the evaporation rate of the present invention may be accurately determined prior to use. The liquid metal is contained as a pool in the evaporator, with the surface of the liquid metal confined by the walls of the evaporator. The known evaporator geometry permits accurate calculation of the surface area of the liquid metal, which, in turn, permits accurate calculation of the evaporation rate and subsequent deposition rate of the metal at any given temperature.

A piston used to feed the metal through the capillary tube makes the system inoperable. The small diameter of the capillary tube and the hydrostatic pressure applied by the piston would force the metal through the capillary tube at an undesirably high rate of flow. This is undesirable because it can cause clogging or force the sintered tungsten out of the tube causing a pool of metal to form in the evaporator.

The present invention uses a transport tube connected to a cylinder and piston pump to transport the metal to the evaporator. In the present invention the liquid metal "does not wet" the material used to fabricate the cylinder and piston. Furthermore, the present invention makes no use of capillary material. This feature of the present invention contradicts the combination of Sarraf's capillary tube and Dale's piston. If the liquid metal actually wets the cylinder and piston, then the metal would "leak" past this fitting, depleting the metal reservoir and making the present invention inoperable. Furthermore, Sarraf and Dale, when combined with Zega, De Lange, Bennett and Mercer would be inoperable. In light of such inoperability, one of ordinary skill in the art would *not* be motivated to combine the cited references. Therefore, the cited prior art taken singly or in combination do not teach, suggest or render obvious the use of a transport tube connected to a cylinder and piston pump.

Referring to independent claim 1, the Examiner has cited Sarraf, in view of Zega, De Lange and Dale, and in further view of Bennett and Mercer as rendering all of the elements of claim 1 obvious. The Applicant respectfully traverses the Examiner's argument that a combination of one or more of these references with Sarraf teaches, suggests or renders obvious all of the claimed elements of the present invention.

Sarraf, entitled "Rapid Response Vapor Source", describes a rapid response metal evaporator. In the opinion of the Examiner:

> Sarraf discloses a liquid metal evaporation source for use in MBE process. Sarraf teaches (col. 1, lines 42-45) that MBE evaporators are limited by source depletion. Sarraf solves this problem by providing a heated supply tank of liquid metal melt along with a feed pipe for continuously replenishing the evaporator. Sarraf uses a capillary wick to pump (see col. 2, lines 30-32) the liquid metal out of the supply tank, and he doesn't discuss the use of a piston to push the liquid metal out of the supply tank. (Office Action of February 23, 2007, page 3).

Next, the Examiner cited to Zega, De Lange and Dale, arguing that they "all disclose vaporizers of the type that are continuously supplied with liquid metal from a heated supply tank by pushing the liquid into the feed pipe." (Office Action February 23, 2007, page 3). According to the Examiner, "Zega teaches that this type of recharging system can be applied to feeding any source of evaporation of relatively low melting point." (Office Action of February 23, 2007, page 3). The Examiner also opined that "Zega and De Lange teach that such a supply system should be provided with a separate heater on the feed pipe." (Office Action of February 23, 2007, page 3). The Examiner further stated that "De Lange (see element 11 of Fig. 2) and Dale (see col. 7, lines 14-19) teach that a piston in the supply tank can be used to push the liquid metal from the supply tank into the feed tube". (Office Action of February 23, 2007, pages 3-4). The Examiner also stated that "[r]egarding the use of a conducting probe to sense the level of liquid in the evaporator, De Lange (see Fig. 1 and col. 4, lines 38-44) teaches this type of level sensor for sensing the level in an evaporator. De Lange also teaches (col. 4, lines 55-60) that this type of level sensor can be used to control the movement of a piston feeder of the type shown in De Lange's Fig. 2". (Office Action of February 23, 2007, page 4). The Examiner also stated that "Bennett (see Fig. 1, for example) and Mercer (See Fig. 1, for example) teach that a molten metal supply pipe should be provided with its own heater and thermocouple based heater control means, to make sure that the pipe is kept within a temperature range in which it will not become cool enough for the metal to solidify, and also will not become too hot (See Bennett at col. 1, lines 23-37)." (Office Action of February 23, 2007, page 3). Further, "Regarding the use of graphite (which is a refractory material) as recited in claim 3, Zega (col. 8, line 17) teaches that this is a

material that can successfully be used for vapor sources." (Office Action of February 23, 2007, page 4).

In contrast, independent claim 1 recites "an evaporator configured to evaporate liquid metal, said evaporator maintained at a first temperature; a hollow reservoir cylinder having a cylindrical piston, said reservoir cylinder maintained at a third temperature lower than said first temperature; a hollow transport tube maintained at a second temperature less than said first temperature and greater than said third temperature, said hollow transport tube connecting said evaporator and said reservoir cylinder." The claimed invention discloses first, second, and third temperatures for the said evaporator, said transport tube and said reservoir respectively. None of the cited prior art references teach, suggest or render obvious any such three-zone system, with each zone maintaining a different temperature.

The purpose of these three different temperatures is not to keep the system from overheating, as disclosed by Bennett and Mercer's purpose for separate heaters on the evaporator and feed tube. Instead the present invention is directed to using as little power as possible while still maintaining effective metal evaporation. While Sarraf teaches a supply system with a heater and Zega teaches a separate heater on the feed pipe, none of the cited prior art references teach, suggest or render obvious at least three separate heaters for three separate temperature zones for the supply tank, feed pipe and evaporator, respectively, to control the three different temperatures zones (high, intermediate and low). Similarly, De Lange teaches the use of heating elements around the feed tube only, and fails to teach a heating element on the evaporator and the use of three separate temperature zones (high, intermediate and low temperature zones). In fact,

De Lange teaches away from heating the evaporator metal directly by suggesting the use of heat conduction of the liquid metal up the evaporation tube. (De Lange, col. 3, 42-57).

Furthermore, none of the other references even teach three separate temperature zones, each temperature zone having a different temperature. Each of the Sarraf, Zega and De Lange references taken singly and in combination with the Dale, Bennett and Mercer references do not teach a high, intermediate and low temperature zone for the said evaporator, said transport tube and said reservoir, respectively, where the different temperature zones are controlled separately in order to save power.

The next element of claim 1 discloses "at least one conducting probe configured to measure and regulate said liquid metal height within said evaporator; and wherein said at least one conducting probe is configured to sense contact with liquid metal in said evaporator by making a low resistance electrical contact; wherein said conducting probe controls a position of said piston in said reservoir cylinder via an automatic feedback control circuit to regulate the level of said liquid metal in said evaporator to maintain a constant evaporation rate of said liquid metal from said evaporator at a fixed evaporator temperature." Further claim 155 recites "a nosecone disposed at said evaporator to permit said evaporated metal to escape through an opening in said nosecone, said nosecone comprising at least one said conducting probe disposed at said nosecone." The claimed invention discloses a conical nosecone with an attached level sensor, the purpose of the nosecone being "to provide dispersion of the evaporated metal flux to obtain uniform thickness deposition of the metal on the coated substrates." (See Specification, page 31, paragraph 1, line 2). Taken singly or in combination, the cited prior art references fail to disclose any such feature as a nosecone. In fact, Sarraf for

example shows a shaped evaporator with an open top (see Fig. 1). Likewise, De Lange shows an open top (See Fig 3, 33).

The outer radius of the level sensor probe is machined to form a close fit with the inner cylinder walls of the nosecone to improve radiant heat transfer to the level sensor probe due to close proximity with the nosecone sidewall. This configuration also prevents condensation of the liquid metal droplets on the level sensor probe which can cause defects. (See Specification, page 41, paragraph 1, lines 2-4). De Lange teaches the use of a conducting probe to sense the level of the liquid in the evaporator. However, De Lange does not teach, suggest or render obvious the probe attached to a nosecone. In fact, De Lange does not teach a nosecone at all. Without the nosecone, the claimed invention would not operate as intended. As Sarraf, Zega, De Lange, Dale, Bennett and Mercer all fail to disclose a nosecone, none of these cited references can teach, suggest or render obvious the probe disposed at the nosecone. Therefore, the combination of all the prior art references fails to teach, suggest, or render obvious an evaporator with a nosecone disposed therein.

As discussed at length above, Sarraf taken in view of Zega, De Lange and Dale, and taken in further view of Bennett and Mercer, fail to teach, suggest or render obvious all of the elements of claim 1. This claim is patentable over the cited prior art for at least the reasons discussed above. Therefore, the Applicant respectfully requests the withdrawal of the 35 U.S.C. § 103(a) rejection of claim 1.

Independent claim 49 claims "a first zone maintained at a first temperature; a second zone maintained at a second temperature lower than said first temperature; and a third zone maintained at a third temperature lower than said second temperature; wherein

each of said first, second and third zones includes a heater element for sensing and regulating said first, second and third temperatures of said first, second and third zones to prevent solidification of liquid metal; and wherein first, second and third temperature zones are in fluid communication." The cited elements of claim 49 are analogous to those discussed above for claim 1. Therefore, claim 49 is patentable over the cited prior art for at least the same reasons as the temperature and heater elements of claim 1.

As discussed above, Sarraf taken in view of Zega, De Lange and Dale, and taken in further view of Bennett and Mercer, fail to teach, suggest or render obvious all of the elements of claim 49. This claim is patentable over the cited prior art for at least the reasons discussed. Therefore, the Applicant respectfully requests the withdrawal of the 35 U.S.C. § 103(a) rejection of claim 49.

Independent claim 101 claims "an evaporator; a transport tube; and a reservoir with piston; wherein each of said evaporator, said transport tube and said reservoir include a heater element having a thermocouple for sensing and regulating the temperature; wherein said heater elements heat said evaporator, said transport tube and said reservoir by infrared radiation to prevent solidification of liquid metal in said evaporator, said transport tube and said reservoir; and wherein said evaporator, said transport tube and said reservoir are in fluid communication." The heater elements of the claimed invention heat the evaporator, transport tube and reservoir by infrared radiation. Infrared radiation is useful because it heats opaque, absorbent objects and not the air around them. Infrared radiation requires no intermediate conductor material or convector medium. It passes directly from the source to the receiver. Warmed air rises to the ceiling where it is not needed and wastes fuel dollars spent to heat it. The claimed

invention uses infrared radiation to save power. None of the prior art references taken singly or in combination teaches the use of infrared radiation to heat the heater elements in order to save power. Therefore, the references do not teach, suggest, or render obvious the use of infrared radiation for this purpose.

Further the Examiner has asserted that Zega teaches that graphite can be successfully used for vapor sources. However, the claimed invention uses densified graphite as its refractory material because densified graphite has efficient black-body radiation absorption. Such absorption reduces the required heating element power more efficiently to achieve a selected operating temperature. Therefore, the cited prior art references taken singly or in combination do not teach, suggest or render obvious the specific use for densified graphite of the claimed invention.

As discussed above, Sarraf taken in view of Zega, De Lange and Dale, and taken in further view of Bennett and Mercer, fail to teach, suggest or render obvious all of the elements of claim 101. This claim is patentable over the cited prior art for at least the reasons discussed. Therefore, the Applicant respectfully requests the withdrawal of the 35 U.S.C. § 103(a) rejection of claim 101.

Claims 153 and 154 recite a reservoir and piston configuration according to claims 1 and 101, "wherein said reservoir cylinder and said cylindrical piston are fitted to prevent leakage of liquid metal out of said reservoir cylinder." All pistons seek to prevent leakage. A mathematical formula is provided in the specification relating to the permissible gap between the cylinder and piston and the maximum height the liquid metal can be raised in the evaporator before leaking past the piston gap. (See Specification, generally pages 33-35). The Sarraf patent does not discuss the use of a

piston to push the liquid metal out of the supply tank as the Examiner agrees. (Office Action of February 23, 2007, page 3). The Zega and De Lange patents disclose vaporizers that are continuously supplied with liquid metal from a heated supply tank by pushing the liquid into the feed pipe. De Lange and Dale teach that a piston in the supply tank can be used to push this liquid metal from the supply tank into the feed tube. However, none of these references taken singly or in combination with the other prior art references teaches a reservoir and piston system in which a maximum permissible gap is calculated and used to machine the said reservoir and piston system to prevent leakage of the liquid metal out of the reservoir cylinder. Such leakage could contribute to metal depletion if it occurs and thus, is an improvement the present invention claims.

Claims 2-3, 8-20, 29-31 and 40-48 depend from independent claim 1, claims 50-53, 55, 66-82 and 92-100 depend from independent claim 49, and claims 102-107, 109, 115-116, 118-135 and 144-152 depend from independent claim 101. By virtue of their dependencies, claims 2-3, 8-20, 29-31, 40-48, 50-53, 55, 66-82, 92-100, 102-107, 109, 115-116, 118-135 and 144-152 have all the limitations of the claims from which they depend. Thus, claims 2-3, 8-20, 29-31, 40-48, 50-53, 55, 66-82, 92-100, 102-107, 109, 115-116, 118-135 and 144-152 are patentable over the cited prior art for at least the same reasons as independent claims 1, 49 and 101. Therefore, the Applicant respectfully requests the Examiner's withdrawal of the 35 U.S.C. § 103(a) rejection of claims 2-3, 8-20, 29-31, 40-48, 50-53, 55, 66-82, 92-100, 102-107, 109, 115-116, 118-135 and 144-152.

The Examiner rejected claims 4, 29-31, 51-54, 81-83, 99, 105-108 and 133-135, under 35 U.S.C. § 103(a) as being unpatentable over Sarraf, taken in view of Zega, De

Lange, Dale, Bennett, and Mercer for the reasons stated above, and taken in further view of Chow U.S. Patent No. 5,031,229 ("Chow"). Applicant respectfully disagrees and requests reconsideration of the Examiner's § 103(a) rejection in light of the following comments.

The Examiner cited Chow as teaching the use of pyrolytic graphite to form the heater elements on the outer surface of the evaporator. However, the claimed invention does not claim pyrolytic graphite to form the heater elements. Instead the present invention claims pyrolytic graphite to coat the evaporator, transport tube and reservoir themselves. Referring specifically to claim 4, "wherein at least one of said evaporator, said transport tube and said piston are coated with a layer of Pyrolytic Graphite." As discussed *supra*, graphite is superior for the evaporator, transport tube and reservoir because it has an efficient black-body radiation absorption configured to reduce the power required by the heating element to achieve a selected operating temperature. None of the other cited prior art references teach, suggest or render obvious this feature. The Chow reference taken singly or in combination with the other cited prior art references does not teach, suggest or render obvious the specific use of pyrolytic graphite in the claimed invention.

Claims 4 and 29-31 depend from independent claim 1, claims 51-54, 81-83 and 99 depend from independent claim 49, and claims 105-108 and 133-135 depend from independent claim 101. By virtue of their dependencies, claims 4, 29-31, 51-54, 81-83, 99, 105-108 and 133-135 have all the limitations of the claims from which they depend. Thus, claims 4, 29-31, 51-54, 81-83, 99, 105-108 and 133-135 are patentable over the cited prior art for at least the same reasons as independent claims 1, 49 and 101.

Therefore, the Applicant respectfully requests the Examiner's withdrawal of the 35 U.S.C. § 103(a) rejection of claims 4, 29-31, 51-54, 81-83, 99, 105-108 and 133-135.

The Examiner rejected claims 21-24, 26, 27, 56-59 and 110-113, under 35 U.S.C. § 103(a) as being unpatentable over Sarraf, taken in view of Zega, De Lange, Dale, Bennett, and Mercer for the reasons stated above, and taken in further view of Bahney U.S. Patent No. 2,195,071 ("Bahney"). Applicant respectfully disagrees and requests reconsideration of the Examiner's § 103(a) rejection in light of the following comments.

Claims 21-24, 26 and 27 depend from independent claim 1, claims 56-59 depend from independent claim 49 and claims 110-113 depend from independent claim 101. As discussed above for claims 1, 49 and 101, Sarraf taken in view of Zega, De Lange and Dale, and taken in further view of Bennett and Mercer, fail to teach, suggest or render obvious three separate temperature zones with three separate heating elements for the three separate temperature zones, a nosecone with a probe disposed at the nosecone, or heating elements that heat by infrared radiation. By virtue of their dependencies, claims 21-24, 26, 27, 56-59 and 110-113 feature all of the limitations of independent claims 1, 49 and 101, respectively. Chow further fails to teach, suggest or render obvious any of the limitations discussed above for independent claims 1, 49 and 101. Thus, claims 21-24, 26, 27, 56-59 and 110-113 are patentable over Sarraf taken in view of Zega, De Lange and Dale, taken in further view of Bennett and Mercer, and taken in further view of Bahney. Therefore, the Applicant respectfully requests the Examiner's withdrawal of the 35 U.S.C. § 103(a) rejection of claims 21-24, 26, 27, 56-59 and 110-113.

The Examiner rejected claims 28, 63-65, 116 and 117, under 35 U.S.C. § 103(a) as being unpatentable over Sarraf, taken in view of Zega, De Lange, Dale, Bennett, and

Mercer for the reasons stated above, and taken in further view of Komiyama JP Patent No. 53-019135 ("Komiyama"). Applicant respectfully disagrees and requests reconsideration of the Examiner's § 103(a) rejection in light of the following comments.

Claim 28 depends from independent claim 1, claims 63-65 depend from independent claim 49 and claims 116 and 117 depend from independent claim 101. As discussed above for claims 1, 49 and 101, Sarraf taken in view of Zega, De Lange and Dale, and taken in further view of Bennett and Mercer, fail to teach, suggest or render obvious three separate temperature zones with three separate heating elements for the three separate temperature zones, a nosecone with a probe disposed at the nosecone, or heating elements that heat by infrared radiation. By virtue of their dependencies, claims 28, 63-65, 116 and 117 feature all of the limitations of independent claims 1, 49 and 101, respectively. Chow further fails to teach, suggest or render obvious any of the limitations discussed above for independent claims 1, 49 and 101. Bahney also further fails to teach, suggest or render obvious any of the limitations discussed above for independent claims 1, 49 and 101. Thus, claims 28, 63-65, 116 and 117 are patentable over Sarraf taken in view of Zega, De Lange and Dale, taken in further view of Bennett and Mercer, and taken in further view of Komiyama. Therefore, the Applicant respectfully requests the Examiner's withdrawal of the 35 U.S.C. § 103(a) rejection of Claims 28, 63-65, 116 and 117.

In light of the arguments above, no combination of Sarraf, Zega, Dale, De Lange, Bennett, Mercer, Chow, Bahney and Komiyama disclose all the elements of any of independent claims 1, 49 or 101. Thus, applicant respectfully requests the Examiner reconsider and withdraw this rejection. Because all of the remaining claims depend from

one of these independent claims, the Applicant submits that the rejection of those claims is similarly traversed.

As demonstrated from the above discussion, the present invention is a distinct improvement over the prior art. The present invention claims a liquid metal evaporation source having a means by which the metal evaporation conditions in the source remain constant and thereby ensure a constant rate of evaporation. This requires that the evaporation surface area, the distance to the substrate and the evaporator metal surface temperature remain substantially constant over time. The three separate heated regions for three separate temperature gradients according to the claimed invention accomplish this. (See claims 1, 49 and 101). For the same reasons that the independent claims are not rendered obvious as set forth above, the dependent claims are not taught, disclosed or rendered obvious by the cited references, either alone or in combination.

CONCLUSION

In view of the foregoing, the Applicant submits that the present invention, for the first time, discloses a means and method for a liquid metal evaporation source with an integral level sensor and external reservoir, which employs a three-temperature gradient to ensure a constant rate of evaporation. The specification, drawings and pending claims represent a patentable contribution to the art and are in condition for allowance. Early and favorable action is accordingly solicited.

Respectfully submitted,

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